Rearing Cotton Insect Parasites In The Laboratory

Production Research Report No. 109

Agricultural Research Service
UNITED STATES DEPARTMENT OF AGRICULTURE
In Cooperation With
University of Arizona Agricultural Experiment Station

Contents

Washington, D.C. Issued August 1969

For sale by the Superintendent of Documents, U.S. Government Printing Office
Washington, D.C. 20402 – Price 15 cents

Rearing Cotton Insect Parasites In The Laboratory

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Certain insect species are becoming more injurious to cotton because of the adverse effects of modern insecticides on parasites and predators. Chief among these species are the bollworm (*Heliothis zea* (Boddie)), the tobacco budworm (*Heliothis virescens* (F.)), and plant bugs (*Lygus* spp.), which are markedly resistant to most previously effective insecticides in nearly all cotton-growing areas.

Prior to the widespread and constant use of insecticides on cotton, several dipterous and hymenopterous parasites often suppressed populations of insects that attack cotton. Some of these biological control agents are cultured in the laboratory for use in experiments in which pest populations are to be controlled with inundative numbers of beneficial species. One of the most promising groups under consideration is the Tachinidae, a family of parasites with a wide range of insect hosts. Also of interest is a group of parasites belonging to the families Braconidae, Ichneumonidae, and Mymaridae. Reasonably efficient rearing and handling techniques have been developed for the following species, although methods for rearing the parasites on nonliving hosts are greatly needed.

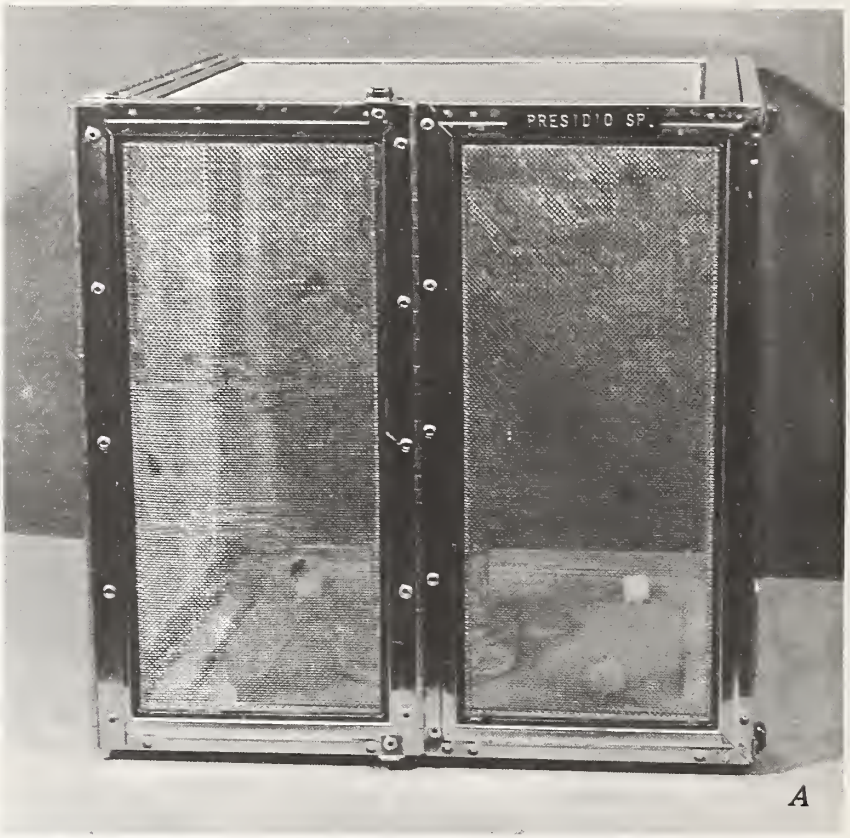
	Hosts
Tachinidae: [1]	
Lespesia archippivora (Riley)	Bollworm, tobacco budworm, beet armyworm, cabbage looper, salt-marsh caterpillar.
Eucelatoria armigera (Coquillett)	Bollworm, tobacco budworm.
Voria ruralis (Fallén)	Cabbage looper.
Exorista mella (Walker)	Salt-marsh caterpillar.
Leschenaultia adusta (Loew)	Do.
Carcelia illota (Curran)	Bollworm, tobacco budworm.
Palexorista laxa (Curran)	Do.
Braconidae:	
Bracon kirkpatricki (Wilkinson)	Boll weevil, pink bollworm, others.
Microplitis croceipes (Cresson)	Bollworm, tobacco budworm.
Ichneumonidae:	
Eriborus sp	Do.
Hyposoter pilosulus (Provancher)	Salt-marsh caterpillar, fall webworm.
Mymaridae:	
Anaphes ovijentatus (Crosby and Leonard)	Tarnished plant bug, other *Lygus* spp.

[1] First 5 tachinids are native and last 2 are introduced species.

Dipterous Parasites

All the tachinids described here are internal parasites of living larvae or pupae of certain species. Rearing requires that hosts be enclosed and be provided food during the developmental period of the parasite. Parasites that can be reared on nonaggressive hosts are more simply and cheaply cultured than those on cannibalistic hosts that require separation. Bryan et al. (*2*) [1] discussed several aspects of

[1] Italic numbers in parentheses refer to Literature Cited, p. 12.



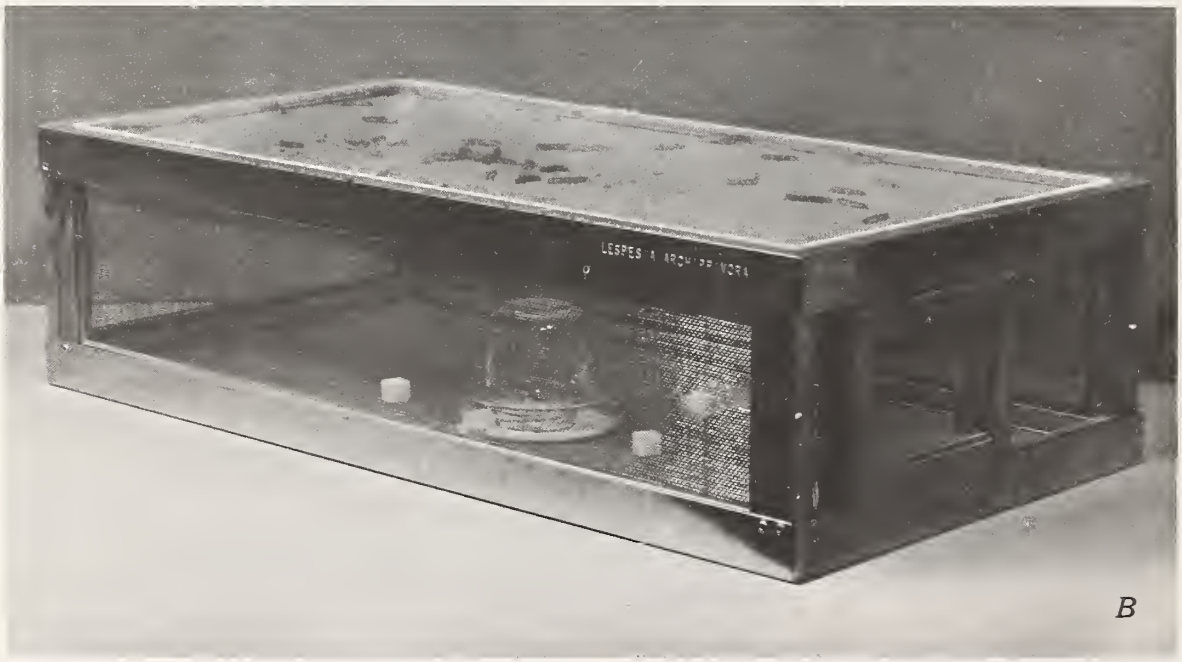


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FIGURE 1.—Aluminum screened cages with bifold front door (*A*) and with sliding door and removable top (*B*). Note plastic sheet confining larvae to top of latter cage.

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FIGURE 2.—Compartmentalized movable rack for cage storage, showing fluorescent illumination. Rack holds two tiers of cages back to back.

rearing *Lespesia archippivora* in four lepidopterous hosts. Patana (*10*) described host rearing and diet-preparation procedures.

Flies, parasitized hosts, and fly pupae are reared routinely at 80° ± 2° F. and 35 ± 15 percent relative humidity.

The flies are confined in aluminum screened cages, 1 by 1 by 1 or 0.5 by 1 by 2 feet (fig. 1), for mating and oviposition. They are given cube sugar, and moisture is provided from water-filled vials inverted on filter papers, 9 cm. in diameter, placed in the bottom of glass petri dishes. The cages are held in a compartmentalized movable rack (fig. 2) and are illuminated from the rear by F20T12 cool white fluorescent tubes for approximately 10 hours daily.

When cannibalistic host species are used, the parasitized larvae are placed individually in 9/16- or 1-ounce clear plastic containers partly filled with lima bean-agar diet (*12*) and capped with tight-fitting lids (fig. 3). These containers are placed on their side in trays that are racked vertically (fig. 4). Whenever feasible, Hexcel sections pressed into pans partly filled with diet and covered with glass sheets (fig. 5) are used instead of individual plastic containers. These sections are 2 inches deep and the smallest dimension of the cell is three-fourths inch.

For the noncannibalistic hosts, 8-ounce

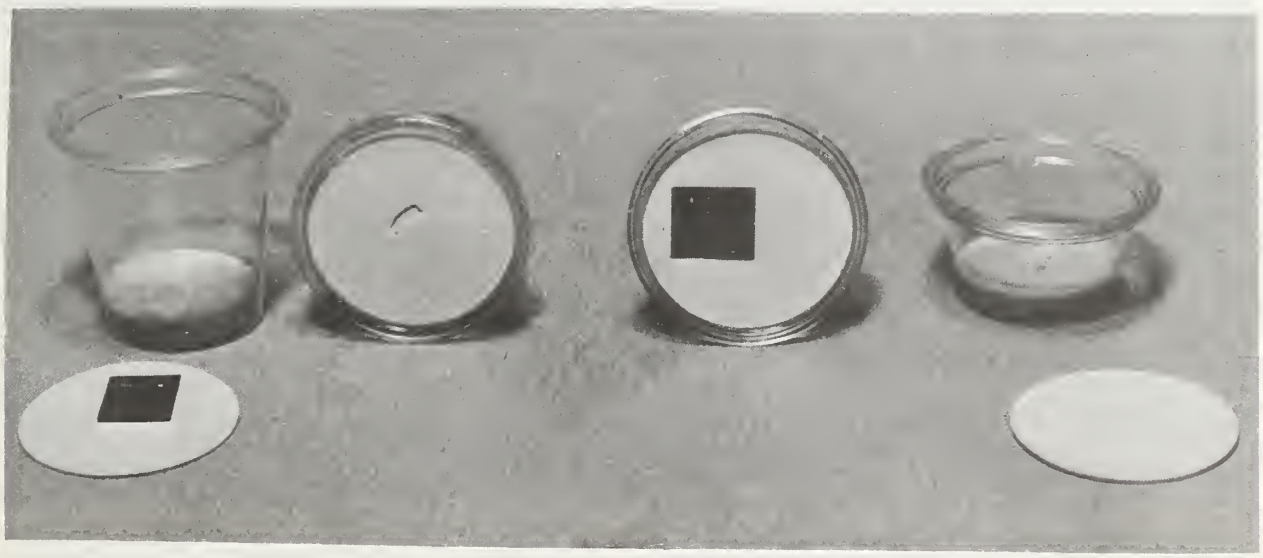

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FIGURE 3.—Clear plastic containers with paper lids for parasitized host larvae.

waxed food containers partly filled with diet and covered with paper lids (fig. 6) are used. Generally the fly puparia are held in 8-ounce waxed food containers with clear plastic cover-all lids (fig. 7) until the flies begin to emerge. The lids are perforated to prevent moisture condensation.

Lespesia archippivora

Lespesia archippivora can be reared on a docile, gregarious host such as the beet armyworm (*Spodoptera exigua* (Hübner)). The host larvae are offered to the flies by placing the larvae on the external, upper surface of a fly cage covered with aluminum screen. The female flies are attracted to the top of the cage by light and lay minute, quick-hatching eggs through the screen on the host larvae. An aluminum cage in current use is shown in figure 1, *B*. As many as 500 fourth- and fifth-instar host larvae can be confined to the top of this cage with a ⅛-inch-thick plastic sheet, which fits into a recessed area in the cage frame (fig. 1, *B*).

After exposure for 2 hours, 30 to 50 host larvae are placed in each of 8- or 16-ounce waxed food containers containing about one-half inch of larval diet (fig. 6). These parasitized larvae feed briefly and die when the parasite maggots emerge in about 7 days at room temperature and pupate on or in the diet and host carcass debris. However, if the host larva is ready to pupate when parasitized, the parasite maggots emerge from the host pupa. On the average, four or five puparia are retrieved from each parasitized host.

The fly puparia are floated out of the containers by agitating the diet with water. They are collected in a strainer, dried on paper toweling, and placed in clean food containers in lots of about 150 for emergence of the adult flies (fig. 7).

The containers of puparia are placed on trays for about 7 days, or until the first flies begin to emerge. Then with the lids removed the

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FIGURE 4.—Rack with trays of plastic containers holding host larvae parasitized by tachinids.

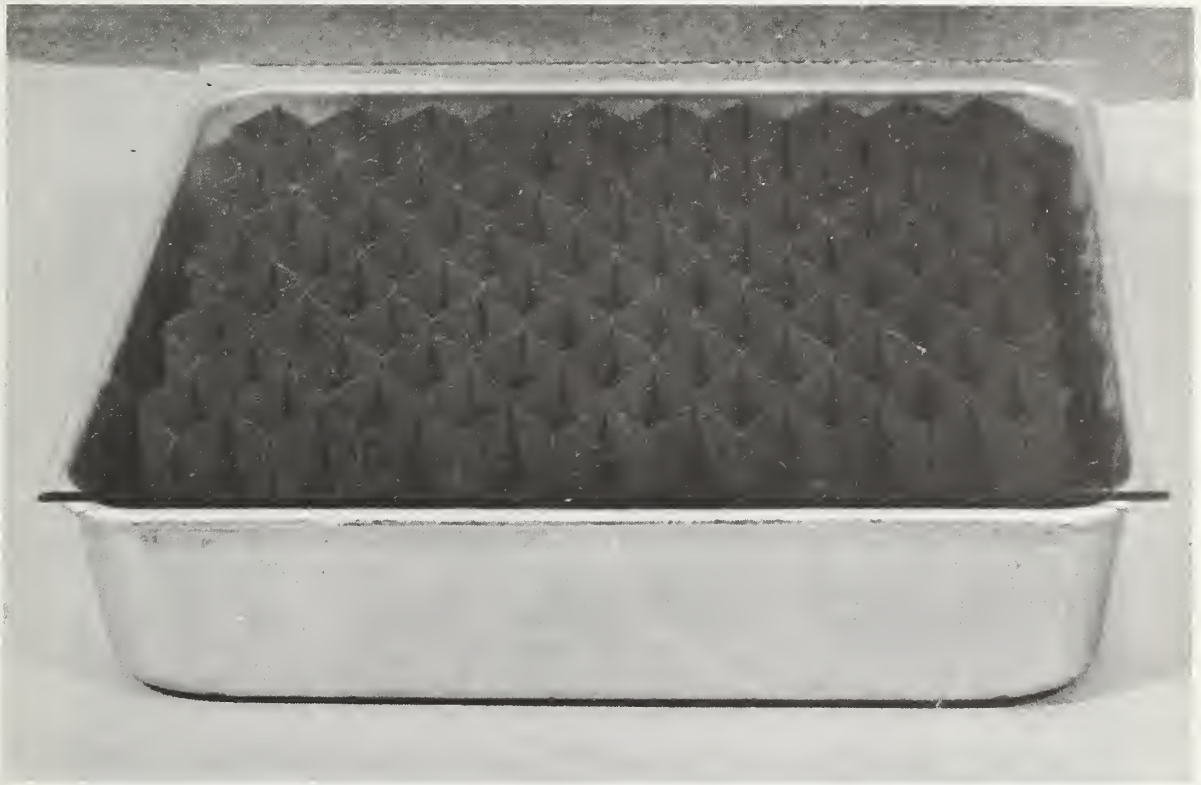

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FIGURE 5.—Fiberglass Hexcel section in pan partly filled with diet and covered with glass sheet. Aluminum screen normally placed below glass has been omitted.

containers are put on the floor of the oviposition cages. As the female flies emerge, they mate with males that emerged earlier. After a 4- to 5-day preoviposition period, the oviposition period may last an additional 25 days. For efficient production, females are discarded after they are 15 days old, because 75 percent of their total oviposition potential has been completed. Generally this is true for the other tachinids cultured in the laboratory.

Bryan et al. (*3*) reported on the fecundity and longevity of *L. archippivora* using beet armyworms as hosts.

Eucelatoria armigera

Eucelatoria armigera effectively parasitizes only the bollworm and the tobacco budworm and is therefore more expensive and difficult to rear. Cannibalism in both hosts requires that parasitized larvae be separated from each other until the parasite maggot emerges. The female flies larviposit readily in larvae of either host species. The tobacco budworm is the chosen laboratory host because it is less cannibalistic, larvae can be reared together until the fifth instar, and therefore it is easier and cheaper to rear than the bollworm.

Approximately 50 male and female flies are held in 1- by 1- by 1-foot cages, where they mate and feed as described for *Lespesia archippivora*. *E. armigera* also has a 5-day preoviposition period. After larviposition begins, 10 to 20 fourth- or fifth-instar *Heliothis* spp. larvae are placed in the cage so that the parasite flies have direct access to them. In this species the larvipositing female parasite must stand on the host to insert the ovipositor into its body cavity. The host larvae are exposed for 2 hours in cages containing about 50 pairs of flies. Superparasitization, which may so severely shorten the host larva's life as to cause death of the parasites, occurs with longer exposure. As many as 17 parasite pupae have been reared from one host, but the flies were very small.

Parasitized host larvae are held either separately in 1-ounce containers with diet and capped with paper lids (fig. 3) or in the cells of fiberglass Hexcel sections (fig. 5) partly filled with diet and covered first with aluminum screen to prevent excess moisture accumulation, then with glass to prevent escape of the larvae.

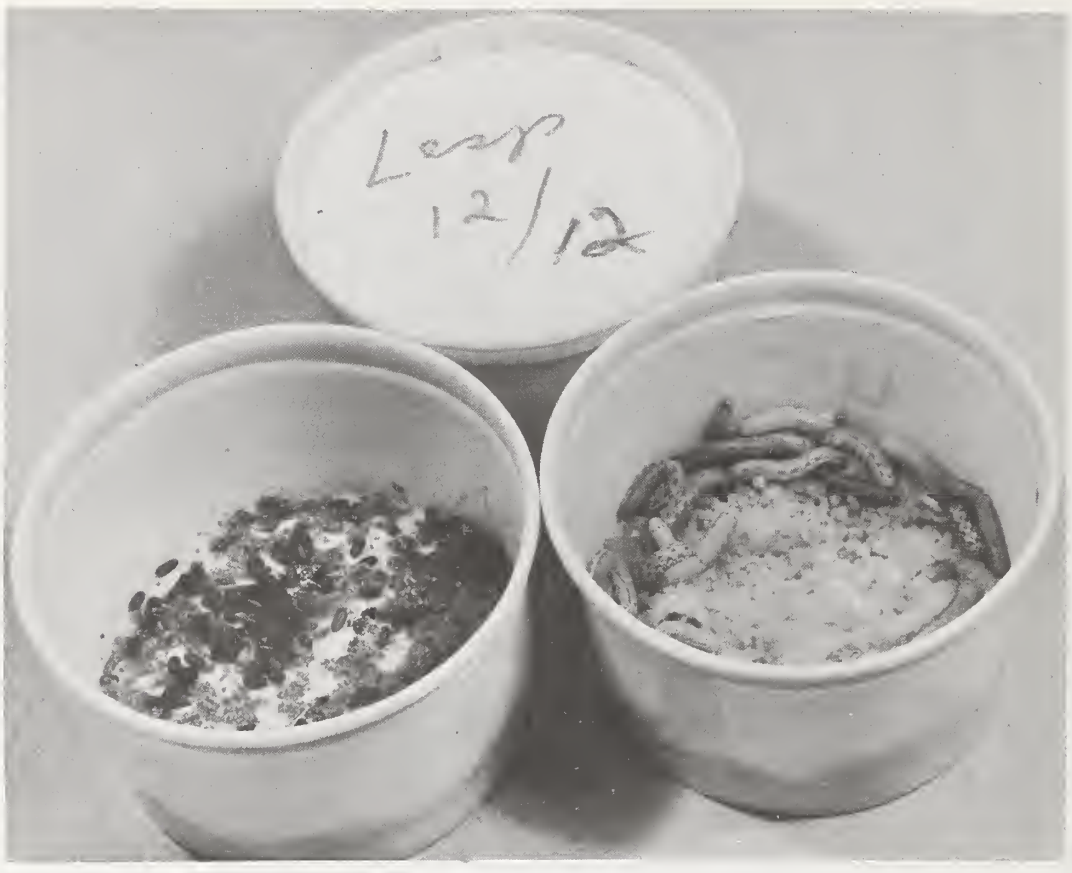

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FIGURE 6.—Eight-ounce waxed food containers with paper lid, showing host larvae on one-half inch of diet.

In either container the host larvae are separated until they die, when the parasite maggots emerge to pupate in or on the diet. Where individual containers are used, each is placed on its side in a tray (fig. 4) so that the host feces fall away from the unused diet. The parasite puparia are either picked with forceps from the diet in the containers or washed from the Hexcel sections. They are placed in food containers, and the flies allowed to emerge as described for *L. archippivora*.

Rearing techniques and development times have been described by Jackson et al. (*8*) for *E. armigera* in *H. zea* and *H. virescens*.

Voria ruralis

Voria ruralis has a narrow host range and for practical purposes is limited to the cabbage looper (*Trichoplusia ni* (Hübner)), which ordinarily is not cannibalistic but is susceptible to an omnipresent polyhedral virus. The disease is fatal for the cabbage looper and this condition often kills the parasite maggots also. Since the virus is rather contagious, individual isolation of the parasitized hosts is the most practical means of preventing infection.

V. ruralis male and female flies are caged and fed as described for *Eucelatoria armigera*. The females mate almost immediately after emergence and begin to lay eggs 8 to 9 days later. Twenty fourth-instar host larvae, preferred by females, are placed in each cage with approximately 25 pairs of flies for about 2 hours. Four to eight eggs are laid on each host looper. The microscopic eggs hatch within 20 minutes and the parasite maggots immediately enter the host.

The parasitized host larvae are removed from the cages and are confined individually on diet in 9/16-ounce plastic containers (fig. 3). They continue developing and spin a cocoon for pupation. The fly puparia and the host larval skin enclosing them are removed from the containers, placed in 0.2 percent sodium hypochlorite-water solution, and agitated until

the parasite puparia float free of the cocoon silk and host skin. The puparia are placed on paper toweling to dry and then in 8-ounce covered food containers (fig. 7) for fly emergence, which occurs about 21 days after oviposition.

Possibly the Hexcel section rearing technique could be used for this parasite to eliminate excessive handling of each host larva.

Development time for the parasite and its host has been described by Jackson et al. (*9*).

Exorista mella

The salt-marsh caterpillar (*Estigmene acrea* (Drury)) is the principal field host of *Exorista mella*. This host is gregarious and not cannibalistic except when injured or when parasitized and healthy larvae are in the same container. Salt-marsh caterpillar larvae are the chosen laboratory host for this parasite, because they are relatively inexpensive to rear, are disease resistant, and are large enough to maintain several parasite maggots through the pupal stage.

E. mella adults are allowed to emerge, feed, mate, and oviposit in 1- by 1- by 1-foot cages. Ten to twenty late-instar salt-marsh caterpillars that have just molted are placed in the cages with the flies. The macroscopic eggs are laid on the host larvae and hatch within a minimum of 50 hours. Thus the caterpillars may shed the unhatched eggs if molting occurs in the interim and thereby escape parasitization.

After 4 hours' exposure to the flies, each host larva is placed in a 1-ounce plastic container half filled with diet and capped with a paper lid (fig. 3). For the following 5 to 7 days the parasitized larva feeds normally and the accumulated fecal material is removed from each container. By the 10th day the parasite maggots emerge from the host larva, prepupa, or pupa and produce two to four fly puparia per host.

The parasite puparia are collected and placed in 8-ounce food containers, which are capped with perforated clear plastic lids (fig. 7). After an additional 10 days as the flies begin to emerge, the containers are placed in clean emergence-oviposition cages (fig. 1, *A*). Preoviposition lasts 4 to 5 days, followed by an effective egg-laying period of about 20 days.

Further information on the development of this parasite is given by Butler et al. (*4*).

Leschenaultia adusta

One of the principal hosts for *Leschenaultia adusta* is the salt-marsh caterpillar. Handling the host larvae after parasitization is similar to that for *Exorista mella*. However, this tachinid is unique among those cultured in the laboratory because the eggs are not laid on or

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FIGURE 7.—Eight-ounce waxed food containers with plastic cover-all lids, showing parasite puparia and emerging flies.

in the host but on a substrate that is later ingested by the host.

After eclosion the large flies are placed in 1- by 1- by 1-foot cages in groups of 10 to 20 to feed for the 2-day mating period. Following an 8-day preoviposition period, the females lay minute, black eggs on any available substrate, although they prefer the edge of cotton leaves. For laboratory rearing, 2- by 6-inch strips of household waxed paper are provided daily as oviposition sites in each cage. The strips, with hundreds of eggs attached, are taken from the cages and the eggs prepared for use immediately or refrigerated for 1 to 7 days. The eggs are moistened with a very weak sodium hypochlorite solution and brushed onto small amounts of diet, which are fed to late-instar salt-marsh caterpillar larvae.

After ingesting the eggs, the host larvae are transferred to 1-ounce plastic containers half filled with diet (fig. 3), where they feed and die as the parasite maggots emerge, or they continue developing to pupation before the maggots emerge. Fecal material is removed from each container midway during this period. When the host larva dies, it and the unused diet are removed and the puparia are left. Usually two puparia are retrieved per parasitized larva.

After the adult parasites emerge in the containers, they are transferred to oviposition cages. The flies are long lived and will oviposit for as long as 24 days, then they die almost immediately.

Possibly Hexcel sections could be used for rearing both *E. mella* and *L. adusta* if the cells were large enough to accommodate the bulky fecal material of the salt-marsh caterpillar. In addition, special provision should be made to suppress the molds that develop in the host feces.

For biological information on a similar species, *Leschenaultia exul* (Townsend), refer to Bess (*1*).

Carcelia illota

Carcelia illota was imported from India, where it parasitizes only the indigenous *Heliothis* spp. In the laboratory it must be cultured on either bollworms or tobacco budworms.

The adult flies are most active in warmth and sunshine. They mate and oviposit readily in 1- by 1- by 1-foot cages when the temperature is above 80° F. Ten to twenty late fourth- or fifth-instar host larvae are placed in cages containing five to 10 pairs of flies for about 6 hours daily. During this time the female parasites lay one or more microscopic eggs on most of the host larvae, which are then placed individually in 9/16-ounce plastic containers partly filled with diet and capped with paper lids (fig. 3).

Since the parasite development is relatively long, the maggot may emerge from the late host larval stage or after the larva pupates. At either stage usually one and not more than two parasite puparia are recovered from each parasitized host. The unused diet and host fecal material are removed from each container when the host or parasite pupates so that the flies can emerge without difficulty.

After emerging in the containers, the flies are placed in oviposition cages. They are relatively short lived and are usually discarded about 15 days after emergence because of their declining rate of oviposition.

Hexcel sections are not used for isolating host larvae because of the extended time for parasite pupation. It is difficult to predetermine whether the maggots will emerge from the larval or pupal stage of the host. Parasitizing younger, smaller host larvae is not a solution to the problem, because they usually die within the first few days after parasitization and the parasite dies also. Since host larvae and pupae, maggots and fly puparia, and host fecal material may all be in the unused diet, the recovery of puparia from Hexcel sections is more difficult than from the containers.

Palexorista laxa

Palexorista laxa was imported from India, where it is parasitic on the native bollworm species. It is cultured on bollworms and tobacco budworms in the laboratory. The flies feed and mate almost immediately when placed in 1- by 1- by 1-foot cages. Then 10 to 20 late fourth- or fifth-instar host larvae are placed in each cage daily with about 25 flies of both sexes. The larvae are exposed for oviposition for about 4 hours. The flies lay several microscopic eggs on each larva.

After removal from the cages, the host larvae are placed individually in 9/16-ounce containers on diet and covered with a paper lid or put in the cells of covered Hexcel sections (fig. 5) partly filled with diet. Seven days later the parasite maggots emerge and form from one to 12 puparia or an average of four to five per parasitized larva.

The puparia are picked from the containers or floated out of the Hexcel and placed in 8-ounce food containers (fig. 7). As the flies begin to emerge, the containers are placed in 1- by 1- by 1-foot cages. The flies are relatively long lived and oviposition continues for 15 to 20 days.

For biological information on *Drino munda*, a related species, see Chauthani and Hamm (*5*).

Hymenopterous Parasites

Unlike the dipterous parasites, the wasps described here generally parasitize small host larvae or eggs. *Microplitis croceipes, Hyposoter pilosulus,* and *Eriborus* sp. attack only late second- or early third-instar larvae. *Bracon kirkpatricki* oviposits on older larvae, which are larger than those parasitized by the other hymenopterans.

Adult wasps can be held in gallon food containers screened with nylon organdy on each end (fig. 8). Each cage is fitted with an inverted water-filled vial, into which is inserted a piece of sponge for moisture. Seedless raisins, opened to expose the soft interior, are provided for food.

Microplitis croceipes and *Eriborus* sp.

Both *Microplitis croceipes,* a native parasite, and *Eriborus* sp., from India, require early-instar bollworm or tobacco budworm larvae as hosts.

The adult wasps are allowed to feed, mate, and oviposit in the food-container cages. Preoviposition in either species is short or does not occur. Each day 10 to 20 young host larvae are placed in the cages containing 10 pairs of wasps and allowed to remain for about 6 hours. The wasps lay eggs inside the host larvae.

The parasitized larvae are placed on diet in containers capped with paper lids. The containers are then placed lidside up in trays (fig. 9) so that excess moisture can escape from the diet, because neither parasite species spins a proper cocoon in an excessively wet environment. After 2 days each container is inverted lidside down so that the medium does not dry out completely. The parasitized host eats relatively little and becomes progressively more sluggish.

About 8 days later the *M. croceipes* larva emerges from the now moribund host and spins a small glabrous, wrinkled cocoon. In *Eriborus* the egg-larval period lasts about 12 days. The larva destroys the host, emerges, and forms a larger, silky cocoon. Occasionally two parasites will emerge and pupate from a *M. croceipes*-parasitized host. The excess diet and host cadaver are removed from each container when the parasite pupates.

M. croceipes and *Eriborus* adults emerge in the containers in 18 to 20 and 20 to 22 days,

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FIGURE 8.—Cages made of gallon food containers screened at both ends with nylon organdy. Cover is removable and waterer is 1-dram vial. Host larvae are placed in cage through hole plugged with cork and removed by taking off cover.

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FIGURE 9.—Containers of wasp parasites are given special handling to remove excess moisture.

respectively, and are released in the oviposition cages. The wasps are relatively long lived and the females oviposit for 15 to 20 days.

Hyposoter pilosulus

A native wasp, *Hyposoter pilosulus,* effectively parasitizes early-instar larvae of the salt-marsh caterpillar as well as such other hosts as the fall webworm (*Hyphantria cunea* (Drury)) (*15*).

The adult wasps do well in gallon food-container cages (fig. 8). They feed, mate, and oviposit almost immediately in young host larvae offered in the original host-rearing container. On alternate days an 8-ounce container with larval diet and about 100 young larvae of the salt-marsh caterpillar is placed in each oviposition cage and removed 24 hours later. In the interim the larvae either feed on the diet or wander over the interior of the cage.

When the host larvae are removed from the cage, they are confined again in the same 8-ounce container with a paper lid. Approximately 12 days later the parasitized larvae die and swell noticeably as the wasp pupates within the caterpillar body wall.

These "mummified" host larvae are accumulated in 1-ounce containers, where they are held for 8 days. Finally the new generation of adult parasites begins to emerge through holes cut in the dry body wall of the hosts. One parasite emerges from each caterpillar.

Tothill (*15*) and Swain et al. (*14*) described the biology and morphology of this species.

Bracon kirkpatricki

Bracon kirkpatricki, from Africa, has a wide range of hosts but apparently prefers larvae of the pink bollworm (*Pectinophora gossypiella* (Saunders)) and the boll weevil (*Anthonomus grandis* Boheman). It is unique among the parasites cultured in the laboratory because the female injects the host with a toxin that immobilizes it. When the host larva becomes quiescent, the parasite places one or more eggs on or near the host body surface.

Although *B. kirkpatricki* can do well in the cages used for *Microplitis croceipes*, a smaller cage has been designed to confine the wasps nearer to the host larvae and also to facilitate exchanging parasitized and unparasitized host material (fig. 10).

Approximately 15 pairs of wasps are confined in the lower half of a 25- by 150-mm. plastic petri dish by covering the opening with nylon organdy. The dish is inverted and a ½-dram vial filled with 20 percent levulose in water and plugged with a cylindrical piece of sponge is inserted through a hole bored in the dish. The wasps can obtain moisture and food from the solution as it fills the one-half inch of sponge that protrudes downward into the cage. Levulose is used because it has less tendency than other sugars to crystallize on the sponge.

Twenty to thirty fourth-instar pink bollworms are confined in the inverted upper half of the petri dish by stretching a 170- by 170-mm. piece of two-ply facial tissue over the opening. The tissue is held in place by the lower half of the dish containing the adult parasites. The two petri dish halves are mated.

The female parasites apparently can sense the movement of the pink bollworms beneath them as they tap the organdy with their antennae. As soon as a suitable host is located, the female probes through the organdy and tissue with her ovipositor, injects the immobilizing substance, and begins to lay several eggs on the host larva. The hosts are exposed for 6 hours daily and as many as 65 eggs may be laid on a single larva. These hatch within 24 hours and the parasites begin their external feeding.

After exposure to the female parasites, the parasitized larvae are held in the same container under the same tissue by means of an unmodified petri dish bottom until the fully fed parasite larvae drop off the host, spin silken cells, pupate, and finally emerge through the tissue as adults. They often mate in this container. Total development takes 9 to 10 days.

The newly emerged adult parasites are collected by aspiration into a glass tube, which can be inserted into the feeder vial hole in the petri dish cage. The adults are blown gently into the fresh cage, in which they may mate, feed, and oviposit after a 4-day preoviposition period. During the ensuing 25 days five offspring may be produced per day per female.

Cross et al. (*7*) described the biology of *B. kirkpatricki* and a rearing technique for this parasite.

Anaphes ovijentatus

Anaphes ovijentatus, a native species, is an egg parasite of the tarnished plant bug (*Lygus lineolaris* (Palisot de Beauvois)), *L. hesperus* Knight, *L. elisus* Van Duzee, *Nabis alternatus* Parshley, *N. americoferus* Carayon, and the three-cornered alfalfa hopper (*Spissistilus festinus* (Say)).

Initial collection of *A. ovijentatus* from the field was accomplished as follows: Ovipositing *L. hesperus* females were caged on alfalfa grown in pots. After 2 days they were removed from the plants and the plants were placed in an alfalfa field for 4 to 5 days. The plants were then recaged and the parasites recovered.

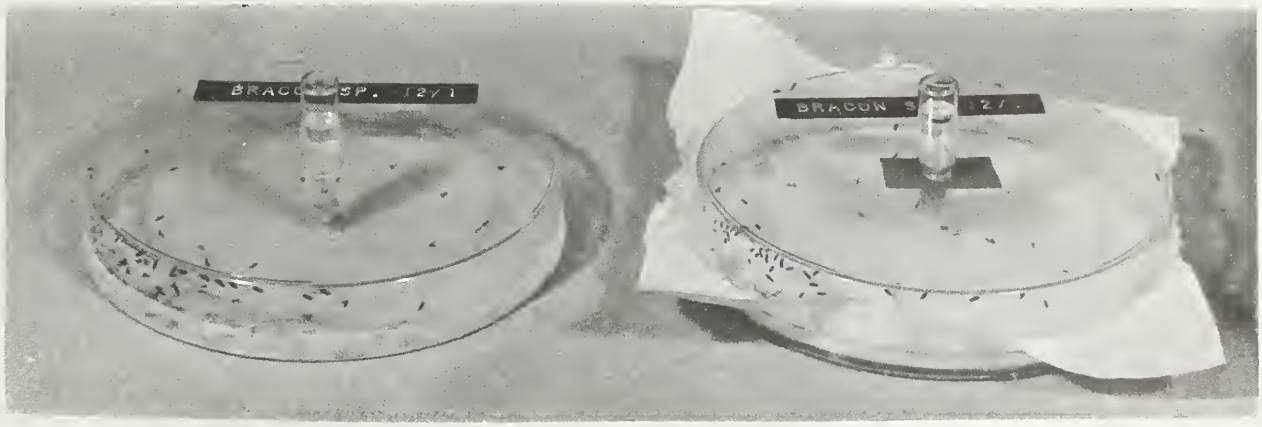

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FIGURE 10.—Cages made of plastic petri dishes: *Left, Bracon kirkpatricki* confined in inverted bottom to which has been added nylon organdy and a ½-dram glass feeder; *right,* petri dish bottom containing wasps inserted into top, which holds larvae to be parasitized under facial tissue.

To rear *A. ovijentatus* in the laboratory requires a suitable host such as the egg of *L. hesperus*. *L. hesperus* is not reared completely in the laboratory but is collected in the field with a sweep net or D-vac insect collector. The nets are emptied into a hood, and *L. hesperus* adults are roughly sorted from the conglomerate collection with an aspirator powered by the intake manifold of a vehicle engine. The collected insects are placed in jars, which are taken to the laboratory in an ice-chilled picnic icebox.

In the laboratory the adults are accurately sorted in a 10- by 8- by 8-inch plastic screen cage with a vacuum pump-powered aspirator and placed in 10- by 8- by 8-inch rearing cages at a rate of 200 to 300 per cage. Every other day they are fed fresh green beans, which also provide oviposition sites. Old beans containing *L. hesperus* eggs are used to rear *A. ovijentatus*.

Oviposition cages for rearing *A. ovijentatus* are 1-gallon ice cream cartons with organdy replacing the bottom and lid (fig. 8). A hole punched in the top side of the cage admits a 1-dram shell vial for introducing new parasites into the cage. As many as 200 parasites are kept in each oviposition cage. Six to twelve green beans containing *L. hesperus* eggs are placed in the oviposition cages and left for 24 to 48 hours. Part of a sugar cube is provided, as well as water from a filter paper in a petri dish half, in which a water-filled container is inverted. The beans are removed from the oviposition cages, and six are held in each quart ice cream carton until the parasites emerge. A 1-dram shell vial is inserted in the lid of each quart carton to capture the parasites as they emerge and are attracted to outside light. Development from egg to adult takes 11 to 12 days at 79° F. and 50 percent relative humidity.

Romney and Cassidy (*11*), Clancy and Pierce (*6*), and Stoner and Surber (*13*) described the biology of this species.

Conclusions

Rearing techniques for endoparasites of gregarious, nonaggressive insect pests are simpler and cheaper than those for parasites of the cannibalistic *Heliothis* species. Of the seven tachinids included in this report, *Lespesia archippivora* is the easiest to culture. Successful rearing of such *Heliothis*-specific parasites as *Eucelatoria armigera, Carcelia illota,* and *Palexorista laxa* requires that the parasitized hosts be separated individually until the parasites emerge. Because the dipterous parasites only attack late-instar host larvae, which are more aggressive, this problem is intensified.

The difficulty of rearing the *Heliothis*-specific wasps *Microplitis croceipes* and *Eriborus* sp. is lessened, because they oviposit only in the smaller more gregarious larvae. *Bracon kirkpatricki* is easiest to rear because it permanently immobilizes the host larva before oviposition and is relatively nonspecific. In addition, the ectoparasitic habit of this species provides some protection because the *Bracon* larvae are free to move during the feeding period.

The most delicate rearing procedure described concerns *Anaphes ovijentatus* because of the fragility of this mymarid and the added complication of a plant substrate that encloses both parasite and host.

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☆U.S. GOVERNMENT PRINTING OFFICE: 1969 0–339-126

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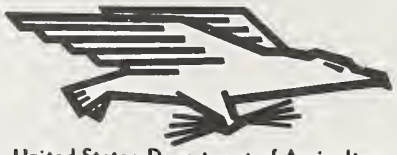

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